

Nov. 25, 1969

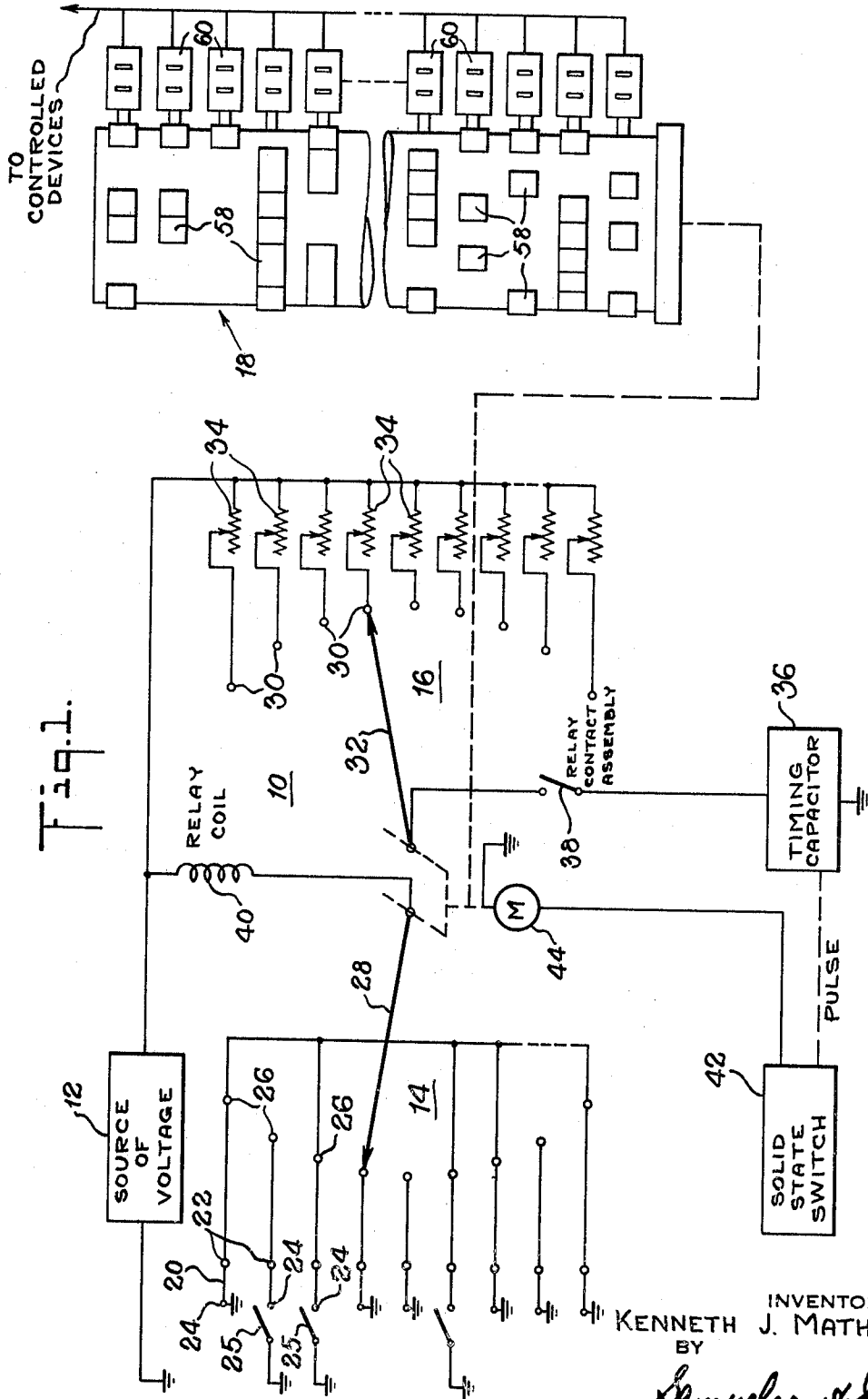
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3,480,792

PROGRAMMER

Filed Aug. 16, 1967

5 Sheets-Sheet 1



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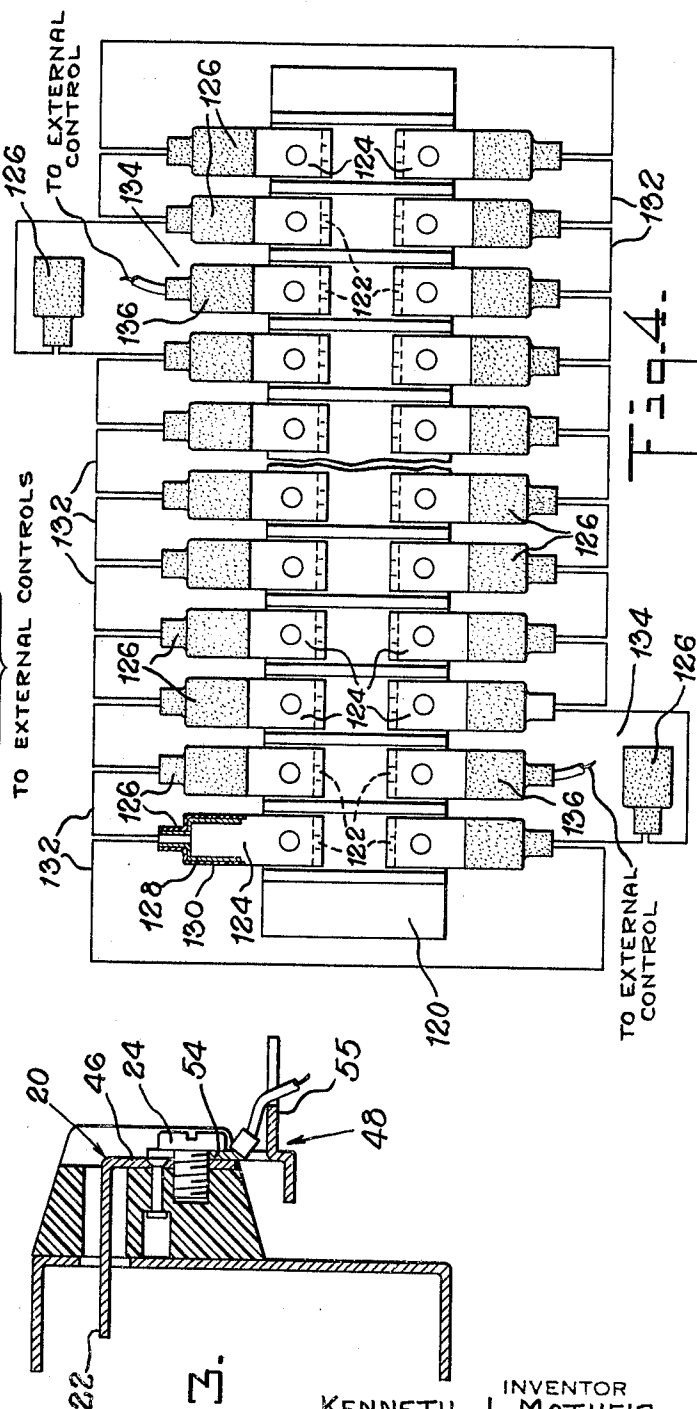
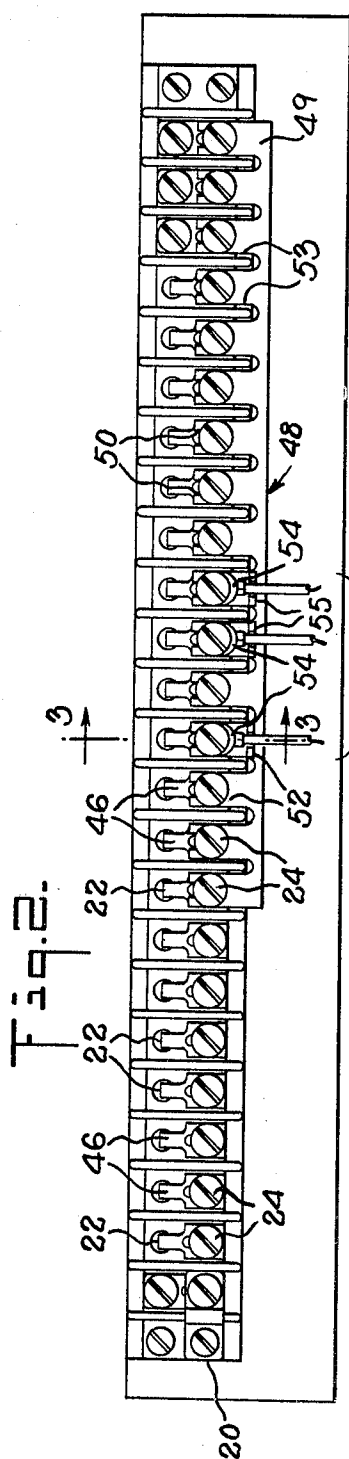
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5 Sheets-Sheet 2



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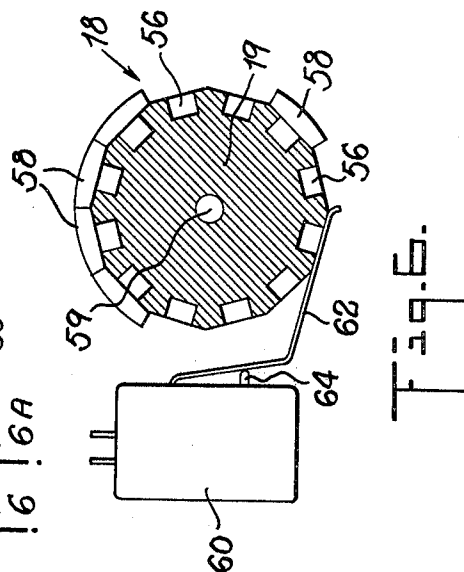
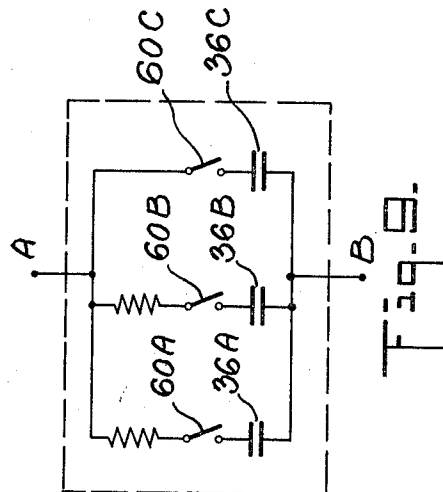
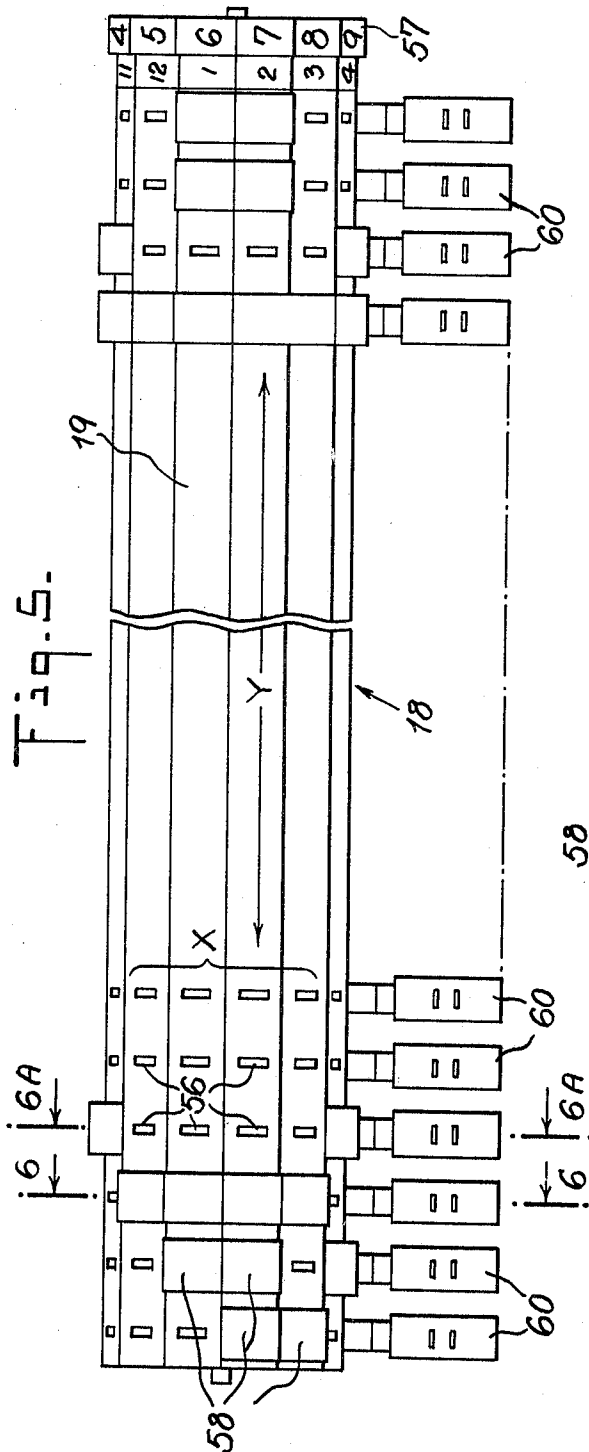
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PROGRAMMER

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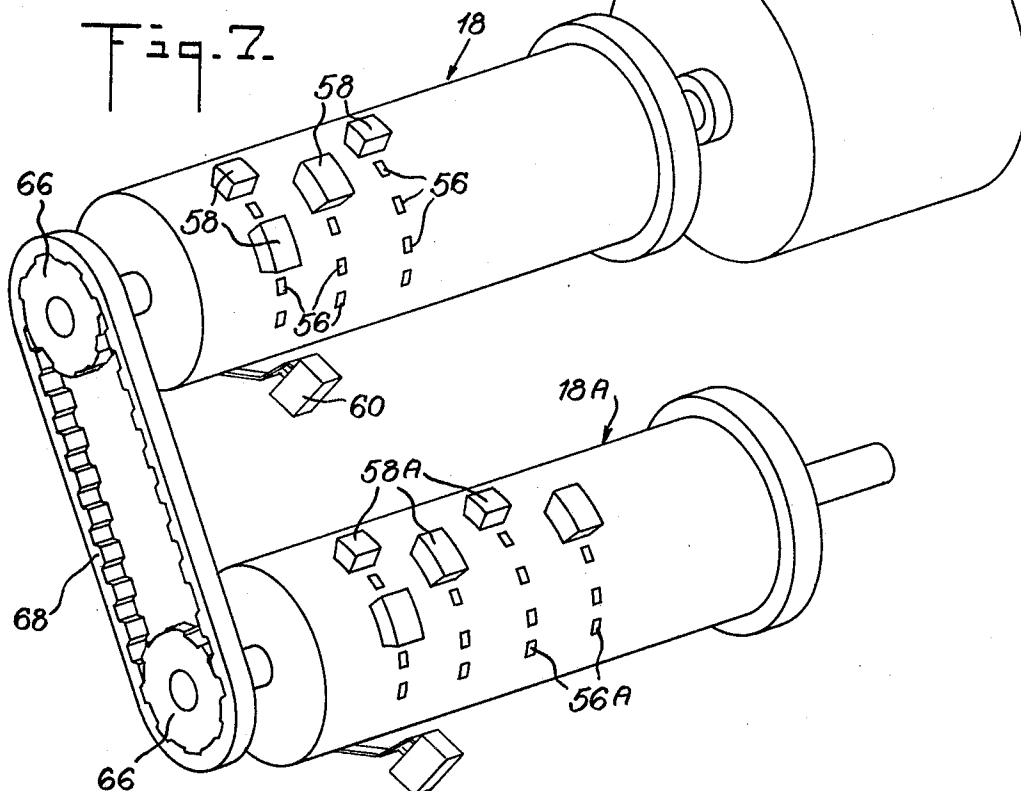
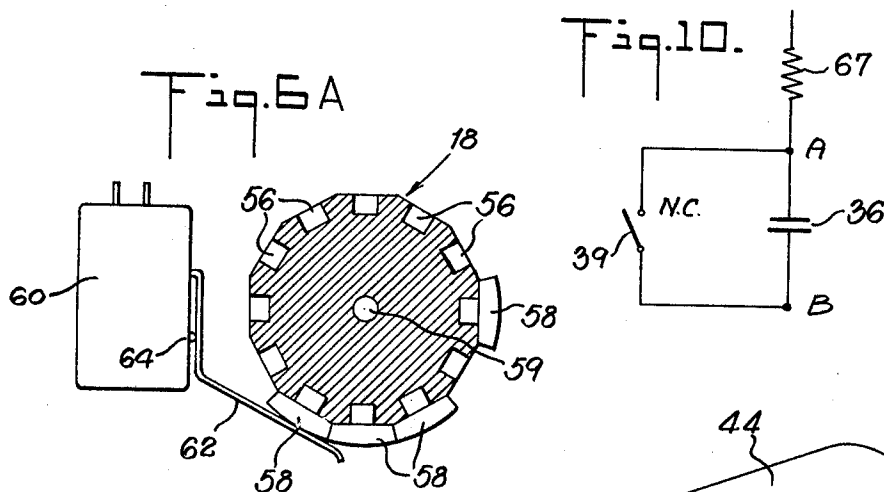
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PROGRAMMER

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5 Sheets-Sheet 4



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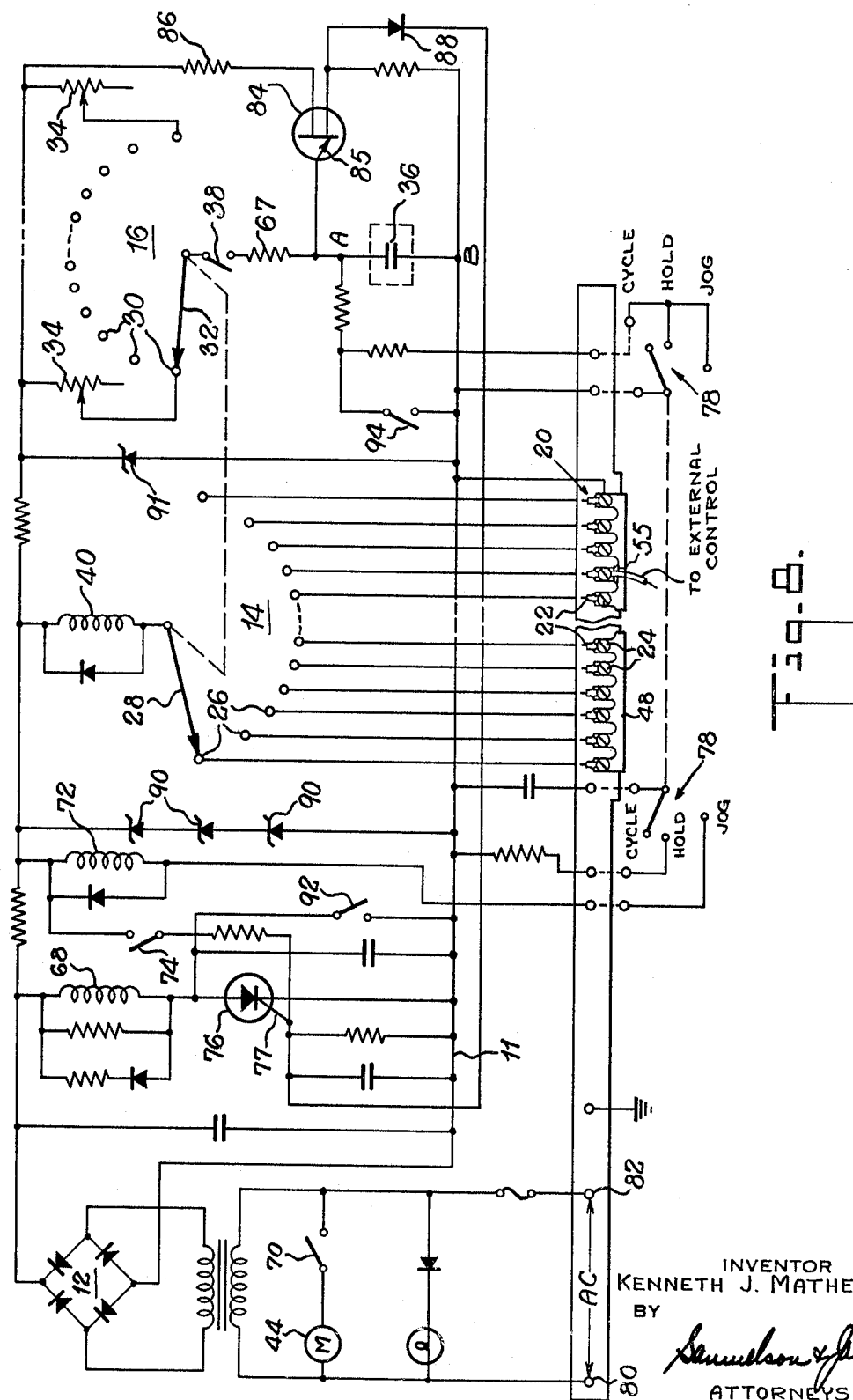
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PROGRAMMER

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3,480,792

PROGRAMMER

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U.S. Cl. 307—141

24 Claims

ABSTRACT OF THE DISCLOSURE

A programmer for controlling a plurality of sequential operations and having a plurality of spaced terminals wherein at least one of the operations depends upon the happening of an event external of the electronic device including providing means for making direct connection among the terminals not associated with the happening of the external event and to a return circuit and connecting the terminal which is associated with the happening of the external event to a control dependent thereupon such that the timing of the electronic device is interrupted until connection is made to the return circuit through the control.

The programmer having a timing circuit including a resistor and a capacitor and means for selecting at least one of a plurality of timing capacitors to change the time constant of the timing circuit.

The invention relates to electronic devices some of whose operations are dependent on the happening of an event external of the device and some of whose operations are dependent on the happening of an event within the device and more particularly to a programmer having such properties. The invention also relates to a simple construction for easily changing the time constant of the timing circuit in the device from operation to operation.

Electronic and magnetic programmers are often used to control various steps or operations in processing. For example, these programmers may be employed to control the operational steps of a plastic blow molder. Since some of the operations of the blow molding process should not take place until the previous step has been completed, it is important that the control for the succeeding step should be actuated by means controlled by the preceding step. For example, a feed line should not be opened to the mold until the previously formed piece has been ejected from the mold.

It is quite easily seen that there are many other conditions which lend themselves to the use of external controls in conjunction with programmers equipped with internal timing circuits and internal controls. It is also readily seen that the same programmer may be used, from time to time, to control a number of different processes which require that the control of individual steps be changed from process to process. Thus, the second step of one process may be required to be externally controlled while the second step of the next process for which the programmer is used may be required to be internally controlled. Moreover, it is often advisable to change the timing of particular steps of the same process when, for example, the type of material being processed is changed. One material may require 10 second timing between steps and the next material may require 100 second timing between steps.

Accordingly, it is an important object of the invention to provide a programmer wherein it is simple and easy to make external connection to one or more particular terminals of the programmer timing circuit.

It is a further object of the invention to provide a programmer having a plurality of operational steps wherein

2

the time constant of the timing circuit may differ from step to step over wide time ranges.

It is a still further object of the invention to provide such a programmer wherein the adjustment of the time constant of the timing circuit may be made simply and the time constant may be easily changed to meet changed operational requirements.

These and other objects, features, advantages and uses of the invention will become apparent during the course of the following description when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a simplified schematic diagram of a programmer of the invention;

FIGURE 2 is an elevational view of a connecting bar which is used to carry out the method of the invention;

FIGURE 3 is a sectional view taken on the lines 3—3 of FIGURE 2, viewed in the direction of the arrows;

FIGURE 4 is a plan view of another embodiment of connecting means used to carry out the method of the invention;

FIGURE 5 is a plan view of a switching drum used with the programmer of the invention;

FIGURES 6 and 6A are cross-sectional views taken, respectively, along the lines 6—6 and 6A—6A of FIGURE 5, viewed in the directions of the arrows;

FIGURE 7 is a perspective view of a plurality of switching drums showing the manner in which several of such drums may be driven from a single programmer;

FIGURE 8 is a schematic diagram of an electronic programmer of the invention;

FIGURE 9 is a schematic diagram of the timing circuits which may be connected between points A and B of FIGURE 8; and

FIGURE 10 is a schematic diagram of an alternative means for actuating and deactuating the timing circuit of the programmer of FIGURE 8.

In the drawings, wherein, for the purpose of illustration, are shown certain preferred embodiments of the programmer of the invention, the numeral 10 designates a programmer, generally. Programmer 10 is seen to comprise (FIGURE 1) source of voltage 12, control switch 14, timing switch 16 and output switching drum 18. Movable arm 28 of switch 14, movable arm 32 of switch 16 and drum 18 are moved in intermittent synchronism by means of motor 44.

Programmer 10 is employed to control a number of succeeding operations of a particular process. Switch contacts 26 are connected to associated terminals 22 on terminal board 20. Each terminal 22 is directly connected to a terminal 24 on the terminal strip 20. When a particular operation is to be controlled by the internal timing of the programmer, the terminal 24 associated with that operation is returned to equipment ground or another return circuit. When the particular operation of the process is to be controlled by the happening of an event external of the programmer, the terminal 24 is connected to an external switch 25 or other external control and thence to equipment ground or other return circuit. Switch 25 may be any type of switch, such as, a time delay switch, a miniature switch which is activated by an external means or any other type of device so long as the switch will be closed at the proper time so that the circuit through switch 14 is connected to equipment ground.

When a terminal 26, which is connected to movable arm 28 of switch 14, is connected to ground through terminals 22 and 24, the circuit from source of voltage 12 through relay coil 40 is closed. When current flows in relay coil 40, upon the closing of the aforesaid circuit, relay contact assembly 38 closes. When relay contact assembly 38, which is normally open, closes, the circuit from source of voltage 12 through the selected timing potentiometer

3

34, contact 30 and arm 32 is closed through the timing capacitor 36. The timing circuit will then time out, pulsing the solid state switch 42 which controls the operation of motor 44, thereby causing it to run. When motor 44 runs, it moves the arms 28 and 32 of switches 14 and 16 to the next position. Drum 18 is ganged with the switch arms and moves to the next position simultaneously therewith. Drum 18 is utilized to make one or more connections to the external, controlled device or devices as shall appear later in this description.

FIGURES 2, 3 and 4 illustrate two means for carrying out the method of the invention for making connection to the external control circuits. Each terminal 22 is connected to its associated terminal 24 by means of a thin conductive strip 46 which is a part of the terminal board 20. Connecting bar 48 comprises a planar surface 49 which is provided with a plurality of openings 50. Adjacent openings 50 are separated by means of slots 53 and the connecting bar 48 fits snugly against terminal board 20 as shown in FIGURES 2 and 3. Preferably, the portions of connecting bar 48 which surround openings 50 are in the form of bifurcated lugs 52. Planar portion 49 is held against terminal board 20 by means of some of the screws 24 which engage the associated bifurcated portions 52 of the connecting bar 48.

When it is desired to control the operation of the programmer from an external switch 25, the bifurcated lug 52 is bent out of the plane of the planar surface 49 as shown at 55 in FIGURES 2 and 3. Then, suitable leads are connected to the terminal 24 by means of a spade lug 54 or a similar connecting mechanism. It can thus be seen that a particular set of terminals 22 and 24 may be connected for internal or external control merely by suitably bending the associated bifurcated lug 52.

In FIGURE 4 there is illustrated an alternative means for practicing the invention. Terminal board 120 is made up of a plurality of thin, flat, electrically conductive tangs 124 which are in turn connected to feed through terminals 122. Terminals 122 are similar to terminals 22 of FIGURES 2 and 3 and each such terminal is suitably connected to its associated terminal 26 of switch 14.

Connection is made to terminals 124 by means of removable female connectors 126. Connectors 126 are electrically conductive and mate with terminals 124 as shown in FIGURE 4. Connector 126 comprises conductive element 128, which makes electrical contact and a tight fit with tang 124, and covering insulation 130. Each connector 126 is connected to its adjacent connector 126 by means of wires 132.

When a particular operation depends upon the happening of an external event, the connector 126 associated with the operation is removed from tang 124 as shown at 134 in FIGURE 4. Now, connector 136, which is similar to connector 126 and is connected to the proper external control, is mated with tang 124.

Thus, it can be seen that a particular set of terminals 122 and 124 may be connected for internal control merely by connecting its associated connector 126. When external control is required, connector 126 is removed from its associated tang terminal 124 and a connector 136 is connected thereto.

In FIGURES 5, 6 and 6A there is illustrated a typical output switching drum which may be used and preferably is used with programmers of the invention. Switching drum 18 (FIGURE 5) is seen to comprise a substantially cylindrically shaped drum element 19 to one end of which is affixed indicia wheel 57. Cylindrical element 19 is provided with a series of openings 56. These openings 56 are arranged in circumferential lines going around the cylinder 18, as indicated by the letter X of FIGURE 5, and are associated with a switch 60 which is located and placed close to the switching drum 18. There are a plurality of these circumferential lines along the longitudinal dimension of the drum 18 and the openings 56 in the plurality of circumferential lines are arranged in rows, as indi-

4

cated by the letter Y of FIGURE 5. The rows are essentially parallel to the axis of rotation 59 of the drum 18. Each of these longitudinal rows Y are associated with a particular position of the switching drum and are denominated with the same indicia as is used to denominate the corresponding positions of the indicia wheel 57.

If it is found desirable to control a number of circuits in a given position of the switching drum 18, then more than one of the switches 60 is operated by the drum 18 when it is in that particular position. In order to operate the switches it is necessary to place an insert 58 in the opening 56 in the circumferential line X of the particular switch to be operated and in the longitudinal row Y of the particular position of the switching drum. When it is not necessary to operate a particular switch 60 in a particular position of the switching drum 18, no insert 58 is inserted in the opening 56 for that particular switch and drum position. When a switch 60 is not to be operated, the switching arm 62 does not move in toward the switch 60 so as to depress the contact element 64. When the switch is to be operated, the switching arm 62 is depressed by the insert 58 and thereby moves the contact element 64 into the switch body 60. These two conditions of switch operations are illustrated in FIGURES 6 and 6A. Depending upon the particular operation controlled by a particular switch the switch may be a normally open switch which is closed when the contact element 64 is depressed or a normally closed switch which is opened when the contact element is depressed.

It is often desirable to actuate more switches in certain positions of the switching drum than are reasonably available on any normal sized drum. In such cases, a plurality of drums may be connected in mechanical synchronism as illustrated in FIGURE 7. Drum 18A is connected so as to operate in synchronism with drum 18 which is rotated by means of motor 44 by connecting the pair of geared pulleys 66 on the two drums 18 and 18A by means of timing belt 68. Timing belt 68 is of the type well-known in the art and is provided with a series of notches therein which engage the depressions in the geared pulleys 66. Such timing pulleys and belts are manufactured, for example, by Browning Manufacturing Company of Maysville, Ky. as parts numbered 14XL BO37 and 120XL O37. Another technique which may be used to operate drums 18 and 18A in synchronism is to actuate a motor which is connected to drum 18A from a switch operated by drum 18. It has been found that the mechanical system illustrated in FIGURE 7 produces eminently satisfactory results and has the additional advantage of using only a single electric motor to operate all of the drums. It is within the contemplation of the invention to use more than one slave drum in connection with the operation of the primary switching drum 18.

Basically, programmer 10 of FIGURE 8 operates when silicon controlled rectifier (SCR) 76 is fired by pulsing its gate 77. Gate 77 of SCR 76 may be pulsed by applying a suitable voltage to it through rectifier 88, or by shorting out SCR 76 by means of switch 92, or by placing ganged switch 78 in the Jog position. When SCR 76 is conducting, the relay coil 68 is energized thereby closing contacts 70 and causing motor 44 to run. This causes the ganged switches 14 and 16 and the drum 18 (not shown on FIGURE 8) to move in synchronism to the next position. When the switches and drum reach the next position, the motor turns off. In order to change the timing of a particular step within a given time range, the appropriate, associated timing potentiometer 34 is adjusted to accomplish this purpose. Since the time constant of the timing circuit is a product of the resistance and capacitance of the circuit, the time constants from step to step of the programmer of FIGURE 8 will remain within a given time range. A simple means for obtaining time constants differing by a considerable amount from step to step will be described later in this description.

Operation of the programmer 10 of FIGURE 8 proceeds as follows: A-C voltage is applied to terminals 80 and 82 of the device. This applies a voltage to two of the terminals of bridge rectifier 12. The output of bridge rectifier 12 is full wave, direct current and applies a D-C voltage to the upper line of FIGURE 8. When the circuit from source of voltage 12 is closed through relay coil 40, arm 28 and contact 26 of switch 14, normally open relay contact assembly 38 closes. When relay contact assembly 38 closes, the timing circuit which is comprised of timing potentiometer 34, current limiting resistor 67 and timing capacitor 36 starts to time out. Emitter 85 of unijunction transistor 84 is connected to capacitor 36 and as capacitor 36 charges, it eventually reaches the level necessary to cause unijunction transistor 84 to conduct. This causes a current to flow through rectifier 88 to the gate 77 of SCR 76. Resistor 86 serves to set the potential at which unijunction transistor 84 will conduct. When gate 77 of SCR 76 is pulsed, current flows from the source of voltage 12 through relay coil 68. This causes relay contact 70 to close and motor 44 to run. Motor 44 runs and moves switches 14 and 16 and drum 18 to the next position. It can be readily seen that it is necessary for the circuit through relay coil 40 and switch 14 to be connected to the return circuit 11 in order for the programmer 10 to move to the next step.

Zener diodes 90 and 91 are used to obtain regulated voltages to be applied to the circuits of the programmer. Switches 92 and 94 are rotating switches which are moved by the shaft of motor 44. Switch 92 is utilized to override SCR 76 and cause programmer 10 to step precisely one step. Switch 92 causes drum 18 to rotate 30° for a 12 step programmer to accomplish this result. The angle of rotation of the drum 18, as controlled by switch 92, depends upon the number of steps in the programmer as given by the formula: rotation angle of

$$\text{drum} = \frac{360^\circ}{\text{number of steps}}$$

Switch 94 rotates with the drum 18 and closes as the drum starts to rotate, thus short circuiting capacitor 36 and thereby discharging it. Before the rotation of drum 18 is completed, switch 94 opens to prepare the timing circuit for the next timing step.

In order to increase the flexibility of the programmers of the invention, it has been found advisable to make other timing capacitors available in addition to capacitor 36 which is contained in the programmer as illustrated in FIGURE 8. This may be done in either of two ways: the first, contemplates the removal of capacitor 36 and the substitution of the circuit of FIGURE 9 across points A and B of FIGURE 8; the second, contemplates leaving capacitor 36 connected between points A and B on FIGURE 8 and adding additional capacitors, in the circuit such as is illustrated in FIGURE 9, in the circuit across points A and B of FIGURE 8.

In FIGURE 9 there is illustrated a preferred embodiment of the manner in which additional timing capacitors or a single timing capacitor may be added to the timing circuit of programmer 10. Switches 60A, 60B, and 60C are mounted adjacent to drum 18. Suitable inserts are placed in the openings in the drum in circumferential line associated with the particular switch which is connected to the particular capacitor 36A, 36B, or 36C which is required for the operation of the timing circuit in the particular position of the switching drum 18. The switch is closed when the insert actuates the arm associated with the switch as was explained in connection with the illustrations of FIGURES 6 and 6A. It can be seen that, if there is no capacitor 36 connected internally in programmer 10, it is always necessary to have an insert in the circumferential line of one of the timing capacitors 36A, 36B, or 36C. If this is not done, the programmer will not time out and its operation will cease. On the other hand if a minimum timing capacitor 36 is always con-

nected internally in the programmer, then the programmer will operate even though one of the capacitors 36A, 36B, or 36C is not connected in the circuit.

Since the time constant of the timing circuit is the product of the resistance and capacitance of the circuit, it can readily be seen that by choosing wide variations of value for capacitors 36A, 36B, and 36C, it is possible to achieve wide timing arrangements far beyond that which is possible with the fine adjustment of the timing potentiometers 34. Because of the use of the switching drum 18 to make the connections to any number of timing capacitors such as timing capacitors 36A, 36B, and 36C, it is possible to add capacitors in parallel and thus increase the time constant of the timing circuit in the desired drum positions even more.

In FIGURE 10, there is illustrated an alternative means for controlling the timing circuit. Relay contact assembly 39, which is actuated by relay coil 40, is substituted for relay contact assembly 38. Relay contact assembly 39 is normally closed so that capacitor 36 is short circuited except when current flows in relay coil 40, at which time relay contact assembly 39 opens and permits the timing circuit to time out.

It is also within the contemplation of the invention to substitute a transistor circuit for relay coil 40 and either relay contact assembly shown to either close the timing circuit as is done by relay contact assembly 38 or remove the short circuit from capacitor 36 as is done by relay contact assembly 39. Any suitable means for interrupting and initiating the timing of the timing circuit may be used in addition to those described and shown herein.

While particular embodiments of the invention have been shown and described, it is apparent to those skilled in the art that modifications are possible without departing from the spirit of the invention or the scope of the subjoined claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a programmer for controlling a plurality of sequential operations each of which may or may not be dependent upon the happening of an event external of the programmer:

a plurality of spaced terminals each of which is associated with one of the plurality of sequential operations;

switch means;

means for connecting a spaced terminal which is not associated with the happening of an event external of the programmer directly to equipment ground;

means for connecting a spaced terminal which is associated with the happening of an event external of the programmer to a control dependent upon the happening of the external event such that connection to equipment ground is made through said control;

a timing circuit comprising a resistance and a capacitance connected in series connected between the switch means and equipment ground;

means for moving the switch means sequentially from operation to operation as soon as the timing circuit for the immediately preceding operation times out and including means associated with the switch means for changing the capacitance of the timing circuit at a predetermined operation.

2. The programmer of claim 1 including:

a terminal strip having a plurality of spaced terminals;

a connecting bar comprising a strip of electrically conductive material having a plurality of openings spaced apart so that the portion of the bar surrounding each opening is engageable with associated terminals of the plurality of spaced terminals, a plurality of slots on the connecting bar spaced so that one of such slots is located between at least some of the adjacent openings whereby a selected portion between adjacent slots may be bent away from the terminal strip to thereby position the open-

ing in the selected portion of the bar so that the said selected portion cannot be engaged with its associated terminal;
 an external circuit;
 means for connecting the external circuit to the terminal which is not engaged by the connecting bar to thereby control the start of the timing of the circuit in that position by means of the external circuit. 5

3. The programmer of claim 1 including:
 a terminal strip having a plurality of spaced, tang terminals; 10
 a plurality of series connected connectors engageable with the tangs such that any of said connectors may be disconnected from its associated tang;
 an external circuit; 15
 means for connecting the external circuit to the tang from which its associated connector has been disconnected to thereby control the start of the timing of the circuit in that position by means of the external circuit. 20

4. The programmer of claim 1 wherein:
 the timing circuit includes a fixed capacitance and the time constant of the timing circuit is changed by the switch means by adding a capacitor in parallel with the fixed capacitance at at least one predetermined position of the switch means. 25

5. The programmer of claim 4 including:
 a terminal at each end of the fixed capacitance;
 a plurality of capacitors;
 the switch means comprising a plurality of switches, 30
 there being a switch in series with each capacitor of the plurality of capacitors, the plurality of capacitors and switches being arranged such that the said capacitors may be selectively connected to and disconnected from the terminals such that the capacitor so selected is connected in parallel with the fixed capacitance whereby the time constant of the timing circuit may be determined. 35

6. The programmer of claim 1 including:
 a pair of terminals connected in the timing circuit; 40
 a plurality of capacitors;
 the switch means comprising a plurality of switches, there being a switch in series with each capacitor of the plurality of capacitors, the plurality of capacitors and switches being arranged such that the said capacitors may be selectively connected to and disconnected 45
 from the terminals such that the capacitor so selected is connected in the timing circuit to thereby determine the time constant thereof.

7. The programmer of claim 1 including:
 a drum having an axis about which it may be rotated and having a plurality of positions around the circumference thereof and a plurality of openings in the surface thereof associated with each position of the plurality of positions; 50
 each of the said plurality of openings associated with each position being in a line parallel to the axis of the drum and the openings of adjacent positions being aligned in a line around the circumference of the drum; 55
 a plurality of output switches mounted in proximity to the drum and aligned with the openings in the circumference of the drum; 60
 inserts insertable in the openings in the drum such that when an insert is placed in a particular opening in the drum, the output switch associated with that circumferential line is actuated when that position on the drum is selected and when no insert is placed in an opening in the drum, the output switch associated with that particular opening is not activated 65
 when that position on the drum is selected;
 the switch means for selecting the time constant of the timing circuit comprising at least one switch mounted in proximity to the drum associated with one circumferential line thereon and connected in series 75

with a circuit including a capacitor so that when an insert is placed in a particular opening and the position on the drum is selected, the circuit will be connected to the timing circuit of the programmer and when there is no insert in a particular opening, the circuit will not be connected to the timing circuit of the programmer.

8. The programmer of claim 7 wherein:
 there is a plurality of such switches each of which is connected in series with a circuit comprising a capacitor and each of which is associated with a circumferential line on the drum;
 the capacitors being of different values whereby the timing circuit's time constant may be changed from position to position of the drum.

9. The programmer of claim 8 including:
 a terminal strip having a plurality of spaced terminals;
 a connecting bar comprising a strip of electrically conductive material having a plurality of openings spaced apart so that the portion of the bar surrounding each opening is engageable with associated terminals of the plurality of spaced terminals, a plurality of slots on the connecting bar spaced so that one of such slots is located between at least some of the adjacent openings whereby a selected portion between adjacent slots may be bent away from the terminal strip to thereby position the opening in the selected portion of the bar so that the said selected portion cannot be engaged with its associated terminal;
 an external circuit;
 means for connecting the external circuit to the terminal which is not engaged by the connecting bar to thereby control the start of the timing of the circuit in that position by means of the external circuit.

10. The programmer of claim 8 including:
 a terminal strip having a plurality of spaced, tang terminals;
 a plurality of series connected connectors engageable with the tangs such that any of said connectors may be disconnected from its associated tang;
 an external circuit;
 means for connecting the external circuit to the tang from which its associated connector has been disconnected to thereby control the start of the timing of the circuit in that position by means of the external circuit.

11. The programmer of claim 8 wherein the timing circuit includes a fixed capacitance and the capacitor selected by the drum is connected in parallel with the fixed capacitance.

12. The programmer of claim 11 including:
 a terminal strip having a plurality of spaced terminals;
 a connecting bar comprising a strip of electrically conductive material having a plurality of openings spaced apart so that the portion of the bar surrounding each opening is engageable with associated terminals of the plurality of spaced terminals, a plurality of slots on the connecting bar spaced so that one of such slots is located between at least some of the adjacent openings whereby a selected portion between adjacent slots may be bent away from the terminal strip to thereby position the opening in the selected portion of the bar so that the said selected portion cannot be engaged with its associated terminal;
 an external circuit;
 means for connecting the external circuit to the terminal which is not engaged by the connecting bar to thereby control the start of the timing of the circuit in that position by means of the external circuit.

13. The programmer of claim 11 including:
 a terminal strip having a plurality of spaced, tang terminals;

9

a plurality of series connected connectors engageable with the tangs such that any of said connectors may be disconnected from its associated tang;

an external circuit;

means for connecting the external circuit to the tang from which its associated connector has been disconnected to thereby control the start of the timing of the circuit in that position by means of the external circuit.

14. The programmer of claim 7 wherein the timing circuit includes a fixed capacitance and the capacitor selected by the drum is connected in parallel with the fixed capacitance.

15. The programmer of claim 14 including:

a terminal strip having a plurality of spaced terminals;

a connecting bar comprising a strip of electrically conductive material having a plurality of openings spaced apart so that the portion of the bar surrounding each opening is engageable with associated terminals of the plurality of spaced terminals, a plurality of slots on the connecting bar spaced so that one of such slots is located between at least some of the adjacent openings whereby a selected portion between adjacent slots may be bent away from the terminal strip to thereby position the opening in the selected portion of the bar so that the said selected portion cannot be engaged with its associated terminal;

an external circuit;

means for connecting the external circuit to the terminal which is not engaged by the connecting bar to thereby control the start of the timing of the circuit in that position by means of the external circuit.

16. The programmer of claim 14 including:

a terminal strip having a plurality of spaced, tang terminals;

a plurality of series connected connectors engageable with the tangs such that any of said connectors may be disconnected from its associated tang;

an external circuit;

means for connecting the external circuit to the tang from which its associated connector has been disconnected to thereby control the start of the timing of the circuit in that position by means of the external circuit.

17. The programmer of claim 7 including:

a terminal strip having a plurality of spaced terminals;

a connecting bar comprising a strip of electrically conductive material having a plurality of openings spaced apart so that the portion of the bar surrounding each opening is engageable with associated terminals of the plurality of spaced terminals, a plurality of slots on the connecting bar spaced so that one of such slots is located between at least some of the adjacent openings whereby a selected portion between adjacent slots may be bent away from the terminal strip to thereby position the opening in the selected portion of the bar so that the said selected portion cannot be engaged with its associated terminal;

an external circuit;

means for connecting the external circuit to the terminal which is not engaged by the connecting bar to thereby control the start of the timing of the circuit in that position by means of the external circuit.

18. The programmer of claim 7 including:

a terminal strip having a plurality of spaced, tang terminals;

a plurality of series connected connectors engageable with the tangs such that any of said connectors may be disconnected from its associated tang;

an external circuit;

means for connecting the external circuit to the tang

10

from which its associated connector has been disconnected to thereby control the start of the timing of the circuit in that position by means of the external circuit.

19. The programmer of claim 7 wherein there is at least a second drum connected to said drum such that both drums move in synchronism.

20. The programmer of claim 19 wherein:

there is a plurality of such switches each of which is connected in series with a circuit comprising a capacitor and each of which is associated with a circumferential line on the drum;

the capacitors being of different values whereby the timing circuit's time constant may be changed from position to position of the drum.

21. The programmer of claim 20 wherein the timing circuit includes a fixed capacitance and the circuit selected by the drum is connected in parallel with the fixed capacitance.

22. The programmer of claim 19 wherein the timing circuit includes a fixed capacitance and the circuit selected by the drum is connected in parallel with the fixed capacitance.

23. The programmer of claim 22 including:

a terminal strip having a plurality of spaced terminals;

a connecting bar comprising a strip of electrically conductive material having a plurality of openings spaced apart so that the portion of the bar surrounding each opening is engageable with associated terminals of the plurality of spaced terminals, a plurality of slots on the connecting bar spaced so that one of such slots is located between at least some of the adjacent openings whereby a selected portion between adjacent slots may be bent away from the terminal strip to thereby position the opening in the selected portion of the bar so that the said selected portion cannot be engaged with its associated terminal;

an external circuit;

means for connecting the external circuit to the terminal which is not engaged by the connecting bar to thereby control the start of the timing of the circuit in that position by means of the external circuit.

24. The programmer of claim 22 including:

a terminal strip having a plurality of spaced, tang terminals;

a plurality of series connected connectors engageable with the tangs such that any of said connectors may be disconnected from its associated tang;

an external circuit;

means for connecting the external circuit to the tang from which its associated connector has been disconnected to thereby control the start of the timing of the circuit in that position by means of the external circuit.

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